Molecular Manufacturing: Top Ten Impacts

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Molecular Manufacturing

- Digital control
- Rapid design
- Local manufacturing from local materials
- High-performance products
- Self-contained, automated factories
- <u>Exponential manufacturing</u>

→ Factories become as cheap as any product

→ Products become as cheap as raw materials

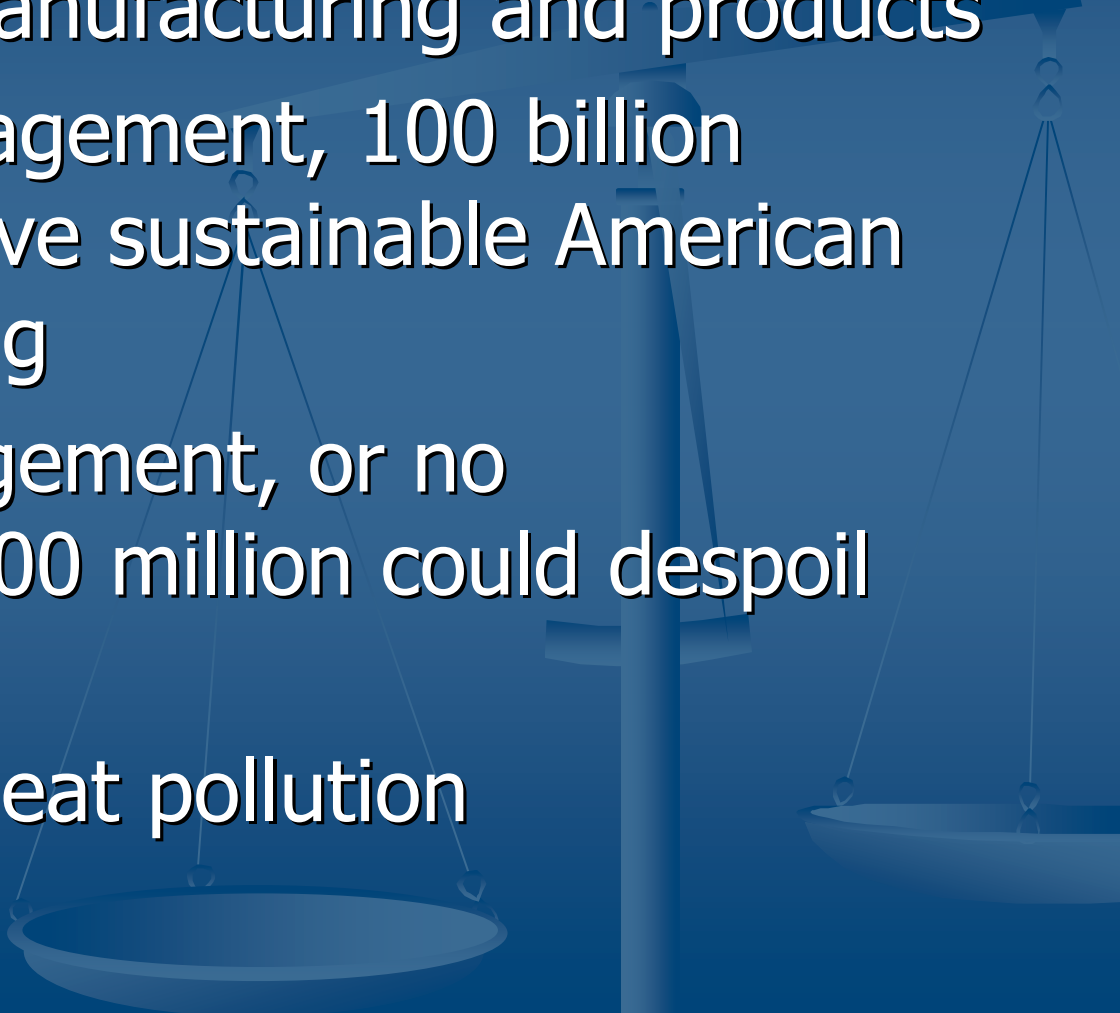(...as cheap to build, not necessarily to buy...)

Diverse, Interconnected Effects

- Infrastructures: Energy, Informatics, etc.
- Environmental Issues
- Business and Trade
- Micro-Economics
- Human Rights, Civil Liberties, etc.
- Medical Ethics and Research
- New-Technology Issues (AI, IA, Space, etc)
- Policing and Criminology
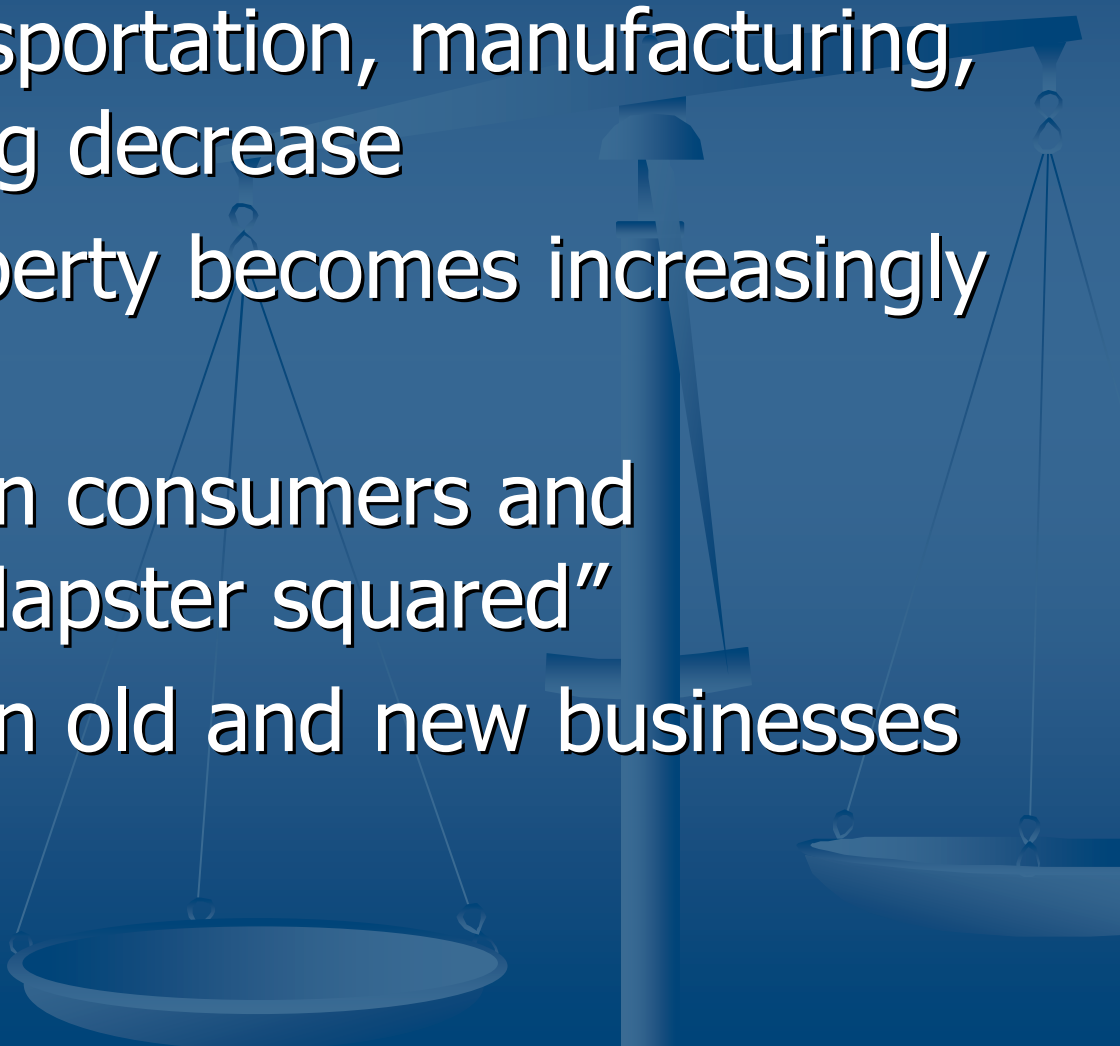- Policy and Governance
- Geopolitics and Peace

Infrastructures

- Within months, could become dominant manufacturing system
- Cheap solar power, including storage
- Inconceivably cheap computers
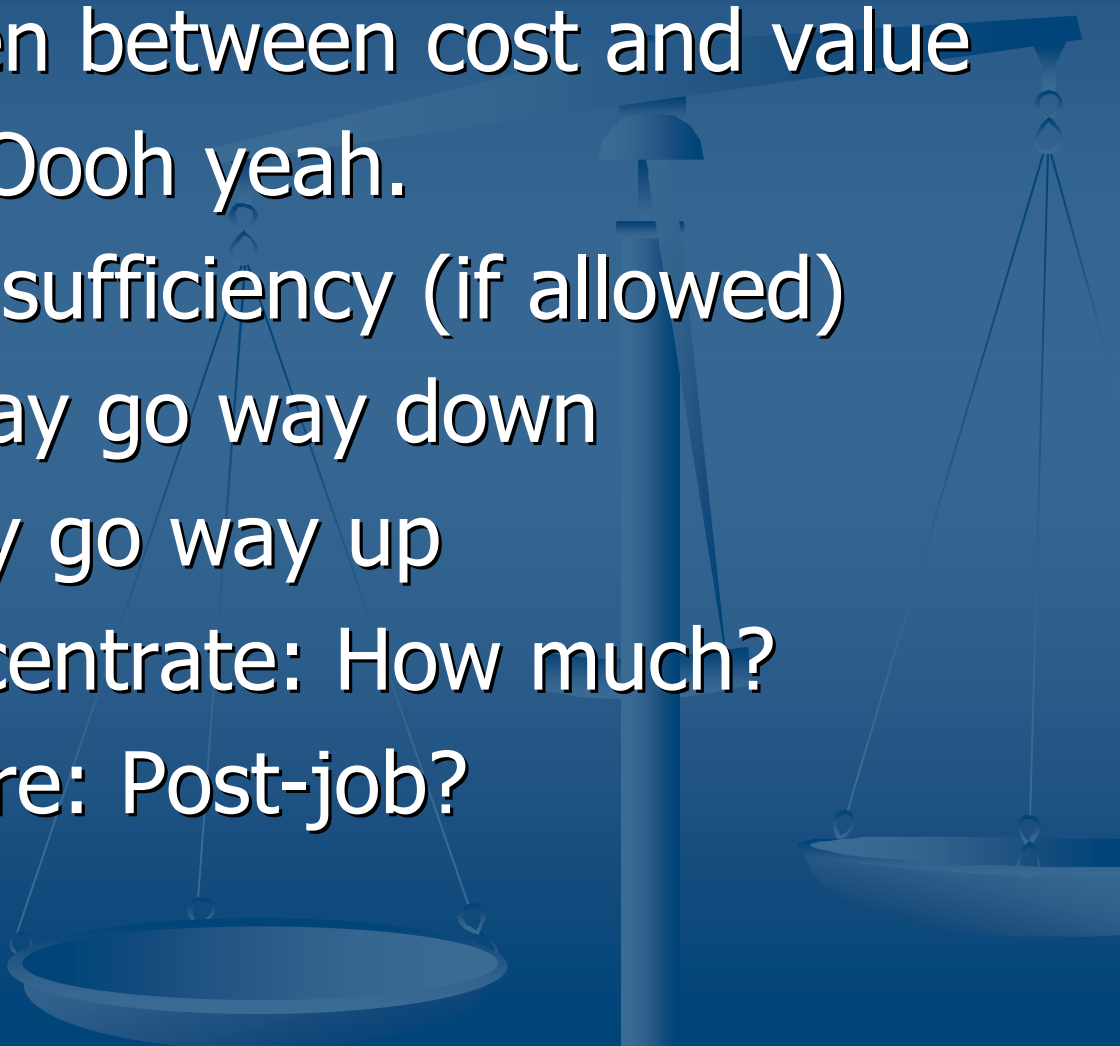- High-performance avionics and airframes for transportation and space

Environmental Issues

- Very efficient manufacturing and products
- With good management, 100 billion people could have sustainable American standard of living
- With bad management, or no management, 100 million could despoil the planet
- Ultimate limit: heat pollution

Business and Trade

- Extraction, transportation, manufacturing, and warehousing decrease
- Intellectual property becomes increasingly important
- Tension between consumers and corporations: "Napster squared"
- Tension between old and new businesses

Micro-Economics

- 3-6 factors of ten between cost and value
- Black market? Oooh yeah.
- Small-scale self sufficiency (if allowed)
- Cost of living may go way down
- Productivity may go way up
- Wealth will concentrate: How much?
- Post-manufacture: Post-job?

Human Rights, Civil Liberties, Humanitarian Issues

- Cheap sensors and supercomputers
  - → Communications (accountability)
  - → Surveillance (oppression)
- Cheap infrastructure creation
  - → Rapid modernization, poverty alleviation
    - …if allowed by corporate/government owners…
- Powerful tech will inspire restrictions
  - → crime, terror, war: freedom vs. security
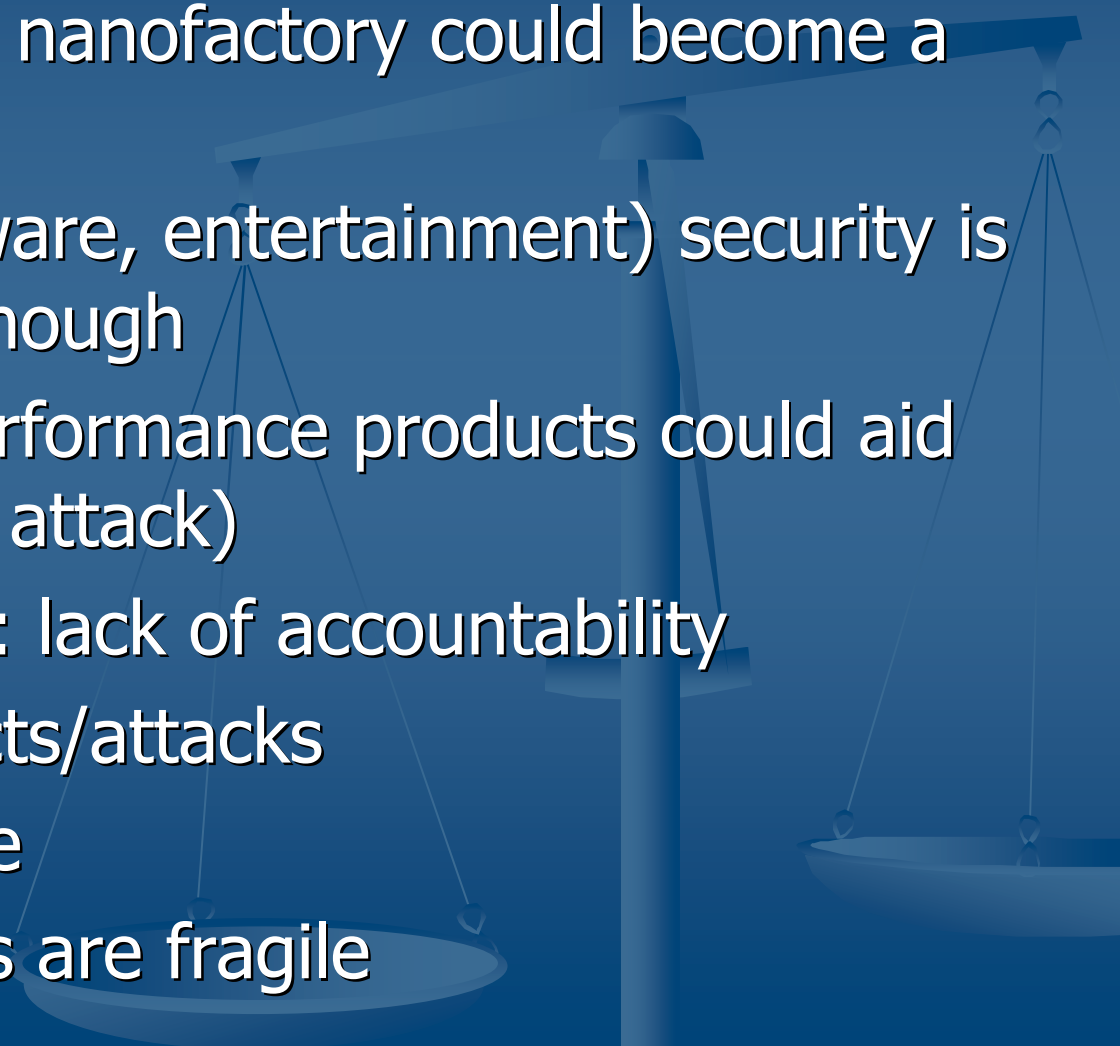- Right to advanced medical care?

Medical Ethics and Research

- Massively parallel sensors
- Cell-sized probes and surgical robots
- Cheap supercomputers
  - → Very rapid medical R&D
    - (No more clinical trials?)
- Neural connections?
- Genome manipulation?
- Physical, even mental augmentation?

New-Technology Issues

- Space
  - Resources
  - A place to expand into
  - Military and security concerns
- AI, IA, Transhumanism
  - Digital machines (easy to engineer) with far more crunch power than the human brain
  - Rapid medical research
  - Runaway or uncontrollable systems?
- Things we haven't thought of yet

Policing and Criminology

- Any (unrestricted) nanofactory could become a WMD factory
- Commercial (software, entertainment) security is not nearly good enough
- Small and high-performance products could aid crime (spying and attack)
- Standoff weapons: lack of accountability
- Cross-border effects/attacks
- Humans are fragile
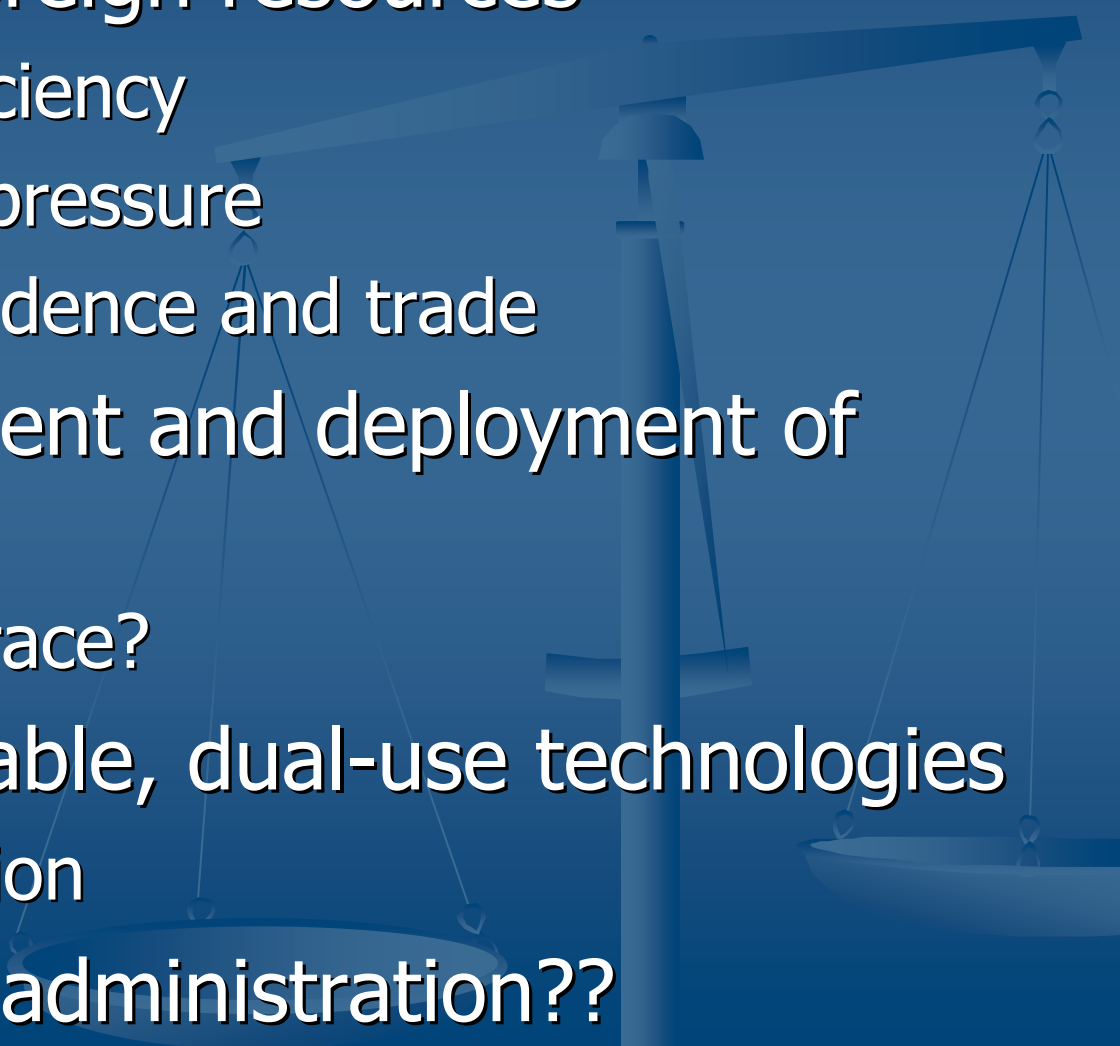- Human institutions are fragile

Policy and Governance

Policy and Governance

- Many vicious cycles to avoid
- Bad policies won't cancel out
- Must balance three kinds of issue:
  - Security – Commerce – Abundance
- On many scales and between jurisdictions
- The Internet is a sneak preview
  - Spam, worms, spyware...
→ Imagine this in the physical world!

Geopolitics and Peace

- Less need for foreign resources
    - Better self-sufficiency
    - Less economic pressure
    - Less interdependence and trade
- Rapid development and deployment of weapons
    - Unstable arms race?
- Extremely desirable, dual-use technologies
    - Rapid proliferation
- Need for global administration??

Call to Action

Recognizing the impact of molecular manufacturing on *each* of these interconnected areas will be necessary for well-informed scenario planning or policymaking on *any* of them.

The alternative is to accept drastic change that we can neither predict nor control.

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